Dr. Laurent, of Marseilles, contributes descriptions of a few Angiosperms from Neocomian rocks. The account of the Jurassic flora of Waikawa, Southland, includes an interesting description of a remarkable petrified forest composed chiefly of trees of an Araucarian type associated with petrified Osmundaceous stems. Forty-eight species are figured; of these at least fourteen are regarded as new, the remainder being widely distributed Mesozoic types. The admirable drawings and photographs are well reproduced, and there is an excellent bibliography.

This latest contribution by a palæobotanist whose untimely death is a serious loss to science is of great value from the point of view of phytogeographical problems; the author has cleared up several difficulties and corrected erroneous statements frequently quoted from the meagre literature on New Zealand plants. It is to be hoped that this thorough piece of work will stimulate New Zealand students to do their best to obtain additional material from the various localities in the islands, and thus provide data for the continuation of Dr. Arber's memorable work.

A. C. S.

VIBRATIONS: MECHANICAL, MUSICAL, AND ELECTRICAL.[1]

V.—*Brass Instruments and the Low "F."*

LEAVING the pendulums which have only two vibrations at a time, the case of brass instruments with a number of simultaneous vibrations was next considered. It is well known that the vibrations from most musical instruments are what is called compound. They consist of a series of tones of commensurate frequencies sounded together. Thus if the pitch of the note is said to be 100 per second, there is not only a prime tone of this frequency, but also a second tone of 200 per second, a third of 300 per second, and so forth. This law applies to strings, to open parallel pipes, and to a complete cone with its base open. It also applies as a close approximation to the brass instruments in general use. This approximation is traceable to the departure from the strictly conical forms as regards the mouthpiece, the bell, and the special shape of the intermediate portion.

In these brass instruments the possibility of this compound tone, or multiple resonance, is utilised for the production of distinct notes. Thus out of the tones possible to the instrument the player may elicit the set 200, 400, 600, 800, etc.; or the set 300, 600, 900, 1200, etc. These would be said to have the pitches of their primes or lowest components, 200 or 300 respectively. Or, to put it musically, they would be the octave or the twelfth of the fundamental (or *pedal*) possible on the instrument. The pedal of the instrument is not usually employed for musical purposes, but can be sounded if specially wished. Now there is a tradition among players of brass instruments that a note called by them a low "F" can be sometimes obtained. This note would have on the foregoing scheme the frequency $133\frac{1}{3}$. At first the possibility of this "F" seems scarcely credible to the theoretician. But after hearing and producing the note the necessity of accounting for its possibility was forced home.

Really the explanation proves very simple. It usually depends upon two points:—(*a*) The *spread* or *diffused resonance* of the pedal, and (*b*) its intentional *mistuning* with respect to the other notes of the instrument. These are taken in order.

(*a*) For theory shows that, other things being equal, the lower the note of such an instrument, the easier it is to force its vibrations out of tune, sharper or flatter. Thus with the pedal the range of resonance is such that the note may be sounded at any pitch whatever over a range of five or six semitones.

(*b*) Since the law of frequencies 100, 200, 300, 400, etc., is only approximately true for these instruments, in order to secure good relative tuning of the higher notes which are in constant use the pedal (which is not used musically) is purposely mistuned. On some instruments it may be, say, D or E♭ instead of C.

Hence, if the central pitch of the pedal is sharpened two or three semitones—and it is possible to force this note both up and down two or three semitones—it becomes possible to sound the pedal of true pitch C, to sound the low "F," and to sound notes of every pitch between. (This was demonstrated by Mr. White on a euphonium, kindly lent by Messrs. Boosey and Co.) The low "F" is also possible on the bombardon. Both these instruments are characterised by large conical tubing, and the low "F" is obtained by the spread resonance of the sharpened pedal.

In the case of the trumpet, cornet, and French horn with much narrow tubing the pedals are flattened, so that a pedal of true pitch can be obtained only by the spread resonance, and the "F" is impossible. On the trombone, which has much small parallel tubing, the low "F" may be obtained occasionally by the downward-spread resonance of the second partial (or note number two), which is an octave above the pedal. (Demonstration.) The pitches of the notes which have been obtained on six types of instruments by four experimenters are shown in Table II.

VI.—*Monochord Vibrations.*

Consideration was next given to the vibrations of stringed instruments, beginning with the monochord because of its striking simplicity

From the work of mathematicians (with a little help from experiment) the various possible vibrations of strings, whether plucked, struck, or bowed, have long been well known. But a little reflection will show that many other problems are still left confronting the physicist. For identical strings, excited in the same way, but mounted on different instruments, will produce very different effects on the ear. In other words, the worth of a violin does not lie in its strings, but in its sound-box.

This leads to the inquiry as to what happens to modify the vibrations as, passing from the strings, they reach in turn the bridge, the belly (or soundboard), and the adjacent air.

It is easy to see that this problem is somewhat complicated, since it presents so large a number of variables. Thus there lie at the experimenter's disposal the pitch of the string, its material and dimensions, the place and manner of excitation, the material and disposition of the associated parts of the instrument, the place of observing the belly, the portion of the bridge observed and the directions of its motions, and, lastly, the spot at which the motion of the air is observed. In this way a scheme for more than a thousand observations could be sketched, even for an instrument with but one string.

Hence, no exhaustive treatment of the problem can be quickly obtained. But a beginning has been made, and by very simple means.

In a series of experiments simultaneous records have been photographically obtained of the vibrations of the string and of some other part of the instrument. The monochord was placed on a table and light from a vertical slit was focussed upon the string near its centre. The real image of this slit, crossed by the shadow of the string, was then focussed by a

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[1] Abstract of a discourse delivered at the Royal Institution on Friday, March 8, by Prof. Edwin H. Barton, F.R.S. Continued from p. 439.

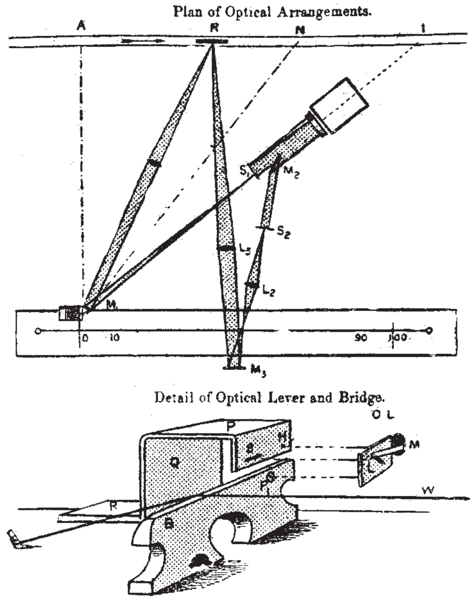
TABLE II.—*Spread Resonance of Lower Open Notes on Brass Instruments.*

Instrument and Key	Maker	Player		PEDAL	(Low "F")	No. 2		No. 3	
Trumpet E♭ in B♭	Boosey	D. J. Blaikley	F F♯ G A♭ A	B♭ (120)	……………………………F F♯ G A♭ A	B♭ (240)			
	Brown	E. H. Barton	E F F♯ G A♭ A	B♭	………………………………………A♭ A	B♭	B		
	Hawkes	,,	A♭ A B♭ B C D♭ D	E♭	D	E♭			
Cornet in B♭		E. C. Pickerill	F.....G A♭ ..	B♭ (120)	……………………… ..F...... G A♭ ...	B♭ (240)			
	Boosey	E. H. Barton	E♭ E F F♯ G A♭ A	B♭	……………………………………G A♭ A	B♭			
Trombone in B♭	Boosey	D. J. Blaikley	F♯ G A♭ A	B♭ (60)	………………(E♭) E F F♯ G A♭ A	B♭, (120)			
	Millereau	E. H. Barton	G A♭ A	B♭	B …………… ………F♯ G A♭ A	B♭	B…………… ..	(180) F	F♯
French Horn in F	Boosey	D. J. Blaikley			C D♭ D E♭ E	F (90)	F♯ ...A B♭ B	C (135)	
	Boosey	E. H. Barton			E♭ E	F	F♯.......B♭ B	C	C♯
Euphonium in B♭	Boosey	D. J. Blaikley		B♭ (60)	B C C♯ D (E♭) …………… A♭ A	B♭ (120)			
	Besson	E. H. Barton	A	B♭	B C C♯ D (E♭)E…………………A	B♭	B		
Bombardon in E♭	Boosey	D. J. Blaikley			(A♭) ………… C D♭ D	E♭			
	Besson	E. H. Barton		E♭ (40)	E F F♯ G (A♭) A ………… C♯ D	E♭ (80)	E		
	,,	A. Wilkinson			E F F♯ G (A♭) ………… C C♯ D	E♭	E		
	Boosey	D. J. Blaikh (March, 1913)		E♭ full	E F F♯ G (A♭) …………… C♯ D fair poor fair full poor fair	E♭ full	E F fair poor		

second lens on to a photographic plate in a dark room. This plate was shot along horizontal rails by elastic cords, which were just slack when the plate received the light. Thus the plate moved uniformly and horizontally, while the shadow of the vibrating string showed its special motion vertically. The corresponding motions of bridge, belly, or air were obtained on the same photographic plate by the light reflected from a tiny rocking mirror, the slight tilt of which was produced by the motion of the part under test. (The principle of this experimental method was then demonstrated, the humped form of the curve due to plucking the string and the two-step zigzag produced by careful bowing being shown.) Fig. 3 gives a diagram of the method for the monochord, also a detail of the rocking mirror for the bridge's motion. Fig. 4 shows photographic traces for the monochord, string, and belly. The two curves alike were taken separately to test if the apparatus worked satisfactorily. The other two curves, slightly different from each other, show the distinction in appearance between the records of a bad and those of a good tone. In this work the assistance of Messrs. C. A. B. Garrett and J. Penzer was acknowledged. In 1914 Prof. C. V. Raman, of Calcutta, by experiments somewhat similar to the above, showed that the forward speed of a string where it is bowed is identical with that of the bow itself.

VII.—*Violin Vibrations.*

If the problems of the monochord were numerous and complicated, those of the violin are still more so, for there are now four strings instead of one: further, all are different in thickness and pitch, and are capable of use in sections of varying length. Again, the sound-box is curved in a variety of ways. Finally, the reinforcement of the belly is asymmetrical. The bass


Plan of Optical Arrangements.

Detail of Optical Lever and Bridge.

FIG. 3.—Monochord apparatus.

bar lies almost under the fourth string, while the sound-post stands near that foot of the bridge which is under the first string. In the work on the violin assistance was received from Messrs. T. J. Richmond, T. F. Ebblewhite, and W. B. Kilby. A number of vibration-curves obtained for the violin were shown on the screen. Fig. 5 gives one set of these, showing the vibrations of each string as indicated by the letters

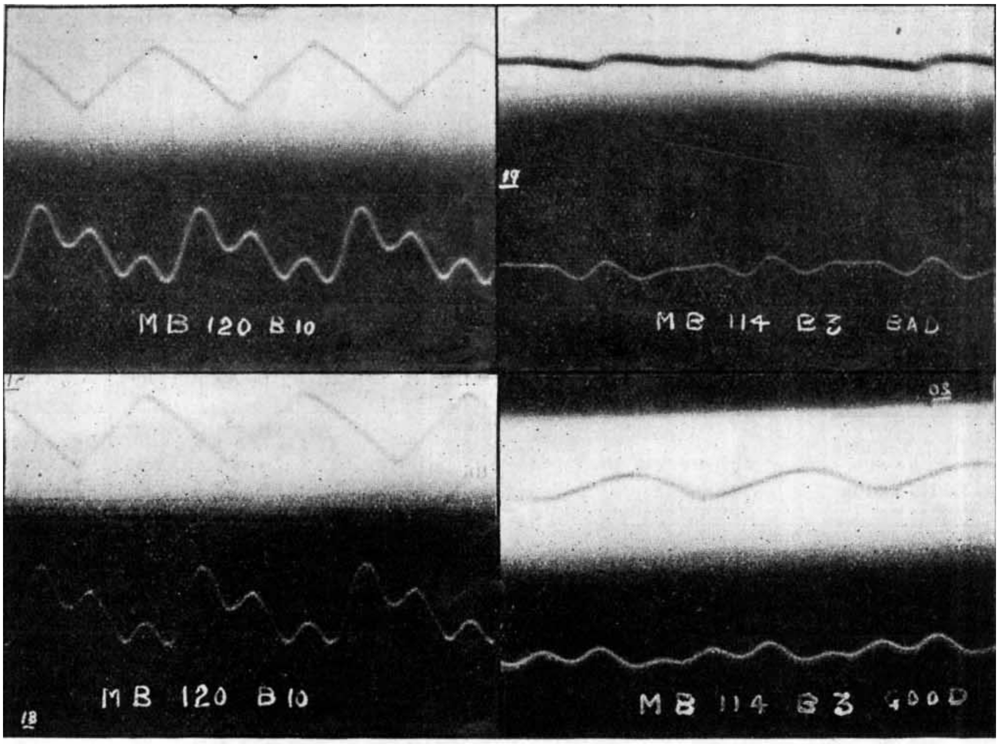


FIG. 4.—Monochord vibration curves.

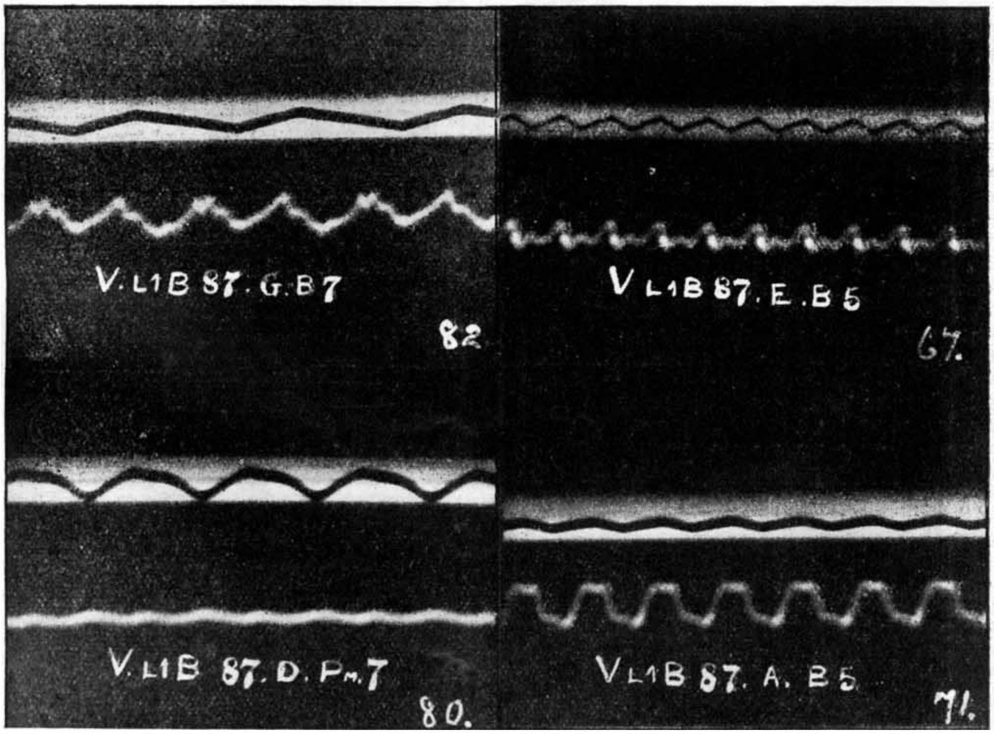


FIG. 5.—Violin vibration curves.

G, D, A, and E. The D string was plucked by a sharp point, the other strings were bowed. The white line shows the longitudinal motions of that corner of the bridge near which the first or E string passes.

VIII.—*Conclusion.*

With respect to the sympathetic vibrations occurring in stringed instruments, it is obvious that, though some little has been done, much more remains awaiting attack. Thus the violoncello, guitar, and harp might be dealt with, but especially, because of its immense vogue, the pianoforte needs thorough investigation. A start was made some time ago by Mr. G. H. Berry, and further researches are now in progress in London under the joint direction of men of science and piano manufacturers.

In the past music-lovers and men of science alike have been deeply indebted to the makers of musical instruments, who have themselves received but little help from science in return. The lecturer expressed the hope that science might shortly pay off part of its debt to the musical craftsmen of the country, and help to make the British piano second to none in the world.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The Moxon medal of the Royal College of Physicians of London has been awarded to Dr. F. W. Mott. The Weber-Parkes prize is not to be awarded this year.

A Vocational Training Bill carrying an appropriation of 400,000*l.* has been passed by the U.S. Congress. It provides for a system of training for soldiers in more than three hundred trades.

A Committee has been appointed to inquire and report as to any improvements which may appear desirable to be made in the conditions of service and in the methods of remuneration of teachers in intermediate schools in Ireland, and in the distribution of the grants made from public funds for intermediate education, and as to the best means in the public interest of effecting such improvements. The members of the Committee are:—The Rt. Hon. T. F. Molony (chairman), the Lord Chief Justice of Ireland, the Rt. Hon. W. J. M. Starkie, Sir J. Larmor, the Rev. P. Canon Marshall, the Rev. T. Corcoran, the Rev. Brother Hennessy, Prof. J. M. Henry, Prof. R. M. Henry, Mr. J. Thompson, Miss H. M. White, Miss M. Ryan, Mr. W. J. Williams, Mr. C. R. Beavan, Miss A. McHugh, Miss E. Steele, Mr. G. Fletcher, Mr. E. Ensor, and Mr. M. Headlam.

The governing body of Birkbeck College has appointed Dr. George Senter to the office of principal recently vacated by Dr. George Armitage-Smith, who had filled the position for more than twenty years. Dr. Senter, who is well known for his research and writings in chemistry, is head of the chemistry department of the college. Formerly he held the readership in chemistry at St. Mary's Hospital Medical School and, in addition to important examining and tutorial posts in London University, held a seat on the University Senate. His election comes at an interesting time in the long and eventful history of the college, which, familiar to many thousands as a pioneer in public education, has continuously developed the scope and nature of its activities under Dr. Armitage-Smith, and has been recognised by Royal Commission as the future centre of evening university work in London.

The report just received of the conference of representatives of provincial museums held at Sheffield on October 16–17, which dealt with the educational value of museums and the formation of war-museums, contains interesting accounts of what is being done in Manchester and other towns to bring the museums into closer relation with the schools, but beyond affording evidence of a desire on the part of museum authorities to depart from their traditionally passive attitude, the discussion shows little sign of any attempt to grapple with the principles upon which successful effort in this direction must be based. Neither circulating collections of museum objects nor organised visits to museums as such solve the educational problem. They often mean nothing better than a more elaborate form of the old-fashioned object-lesson, which is discredited because it commonly touches no vital interest. Reaction against verbalism may easily plunge us into another kind of abstract teaching, which is none the less abstract because it is based on things present to the senses. It is only when contact with an object is revealing, when it illuminates a dark place in our minds or opens up an aspect of the world hitherto unrealised, that it is, rightly speaking, educative. We may use it to give information, of course, but information has in itself slight educational value. From this point of view Mr. Haward's account of his work at the Manchester Art Gallery is the most valuable contribution to the subject. He has in mind a revelation, and, even though the children may not feel the ultimate message he would convey to them, it is precisely the ultimate message which should determine the whole procedure. This is true also of similar work in the museum, and a future conference might well address itself to the problem of this final outcome, for it is in the light of that we may hope to discuss profitably particular proposals and particular practice.

SOCIETIES AND ACADEMIES.

Dublin.

Royal Irish Academy, June 24.—The Most Rev. J. H. Bernard, D.D., Archbishop of Dublin, president, in the chair.—H. **Ryan** and W. **O'Riordan**: α-, β-, and γ-trinitrotoluenes. An attempt was made to ascertain whether differences in the reactivities of the trinitrotoluenes exist which might explain the instability of trinitrotoluene in some rare cases. The behaviour of the three isomers towards alkalis, alkyloxides, amines, hydrocarbons, and aldehydes was examined. All three isomers yield black, amorphous, explosive bodies when heated with alkalis. The β- and γ-isomers have each one nitro-group replaced by a hydroxyl, giving dinitrocresols. The α-isomer yields hexanitrodibenzyl. The β- and γ-isomers readily exchange a nitro-group for an amino-group, the β-isomer being apparently the more reactive. The α-isomer forms additive compounds, without substitution, by interaction with amines. The additive compounds obtained from the γ-isomer and amines readily pass into substitution derivatives. Towards hydrocarbons such as phenanthrene the three isomers behave similarly. While α-trinitrotoluene interacts readily with aldehydes, forming stilbene derivatives, the latter could not be obtained under similar conditions from the β- and γ-isomers.

Paris

Academy of Sciences, July 16.—M. Léon Guignard in the chair.—G. **Bigourdan**: The observatory of the Hôtel of Taranne: works and co-ordinates. This observatory was founded about 1710 by Louville, who was the first to use a filar micrometer in astronomy,